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COGITATIO

Media and Communication (ISSN: 2183–2439)
2019, Volume 7, Issue 2, Pages 115–127
DOI: 10.17645/mac.v7i2.1959

Article

Digital Literacies Learning in Contexts of Development: A Critical Review of Six IDRC-Funded Interventions 2016–2018

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Submitted: 9 January 2019 | Accepted: 10 March 2019 | Published: 11 June 2019

Abstract
As global development agencies and governments seek to address the United Nations' Sustainable Development Goal 4 for Universal Education, evidence of the real impacts of digital literacies interventions in local contexts are needed. This critical review of the designs, impacts and markers of quality of six literacies interventions offers new insights into the strengths and weaknesses of *fixed* and *open* approaches to literacies learning in contexts of development. Open interventions offered greater promise for learning a range of digital literacies practices than fixed interventions, even though fixed interventions, based on mobile and web-based apps were inherently digital. This raises important questions about the ways literacies have been conceptualised in development research.

Keywords
digital learning; digital literacies; development; SDG4; Sustainable Development Goals; universal quality education

Issue
This article is part of the issue "Critical Perspectives on Digital Literacies: Creating a Path Forward", edited by Hiller A. Spires (North Carolina State University, USA).

1. Introduction

The United Nations' sustainable development agenda (2015) focuses on seventeen fundamental and interconnected goals that include the eradication of poverty and hunger, gender equality, and environmental stewardship. Framed by ambitious action plans, the realization of these sustainable development goals (SDGs) will mean a safer, healthier, more equitable, and prosperous world by 2030.

The SDGs inform priority development investments by governments, NGOs, and development agencies including Canada's International Development Research Centre (IDRC). Between 2016 and 2018, the IDRC supported research on more than forty initiatives that respond to Sustainable Development Goal 4 (SDG4)—the call for universal quality education.

Defined in the *Education 2030 Incheon Declaration and Framework for Action for the Implementation of SDG 4* (UNESCO, 2016), *quality education* is understood to be equitable, inclusive, and accessible by design. According to the Incheon Declaration, quality education fosters, "creativity and knowledge, and ensures the acquisition of the foundational skills of literacy and numeracy as well as analytical, problem solving, and other high-level cognitive, interpersonal and social skills" (UNESCO, 2016, p. 8). The declaration describes the importance of digital and information communication technology (ICT) literacies for working and living in economies that are increasingly "knowledge-based and technology driven" (p. 22) and it advocates for systems of schooling that serve these fundamental needs. The declaration identifies the potential for ICTs to strengthen education systems, and encourages their use for knowledge dissemination, for the provision of access to quality learning, and for effective service provision (p. 36). However, as Prinsloo and Krause (in press) write, digital media should be viewed as "translocal resources that operate in local contexts and offer particular kinds of located agency and engagement to young children in ways that are tied up with where they are and who they are" (p. 2). Any evaluation of digitally-mediated learning interventions, including digital literacies interventions, must therefore consider the ways that context will shape meaning-making. A tablet

computer placed in a refugee settlement in Jordan and in a school in rural Cambodia will mean different things and enable different meaning-making activities because, as Prinsloo and Krause suggest, the context and the experiences of the children also differ. This focus on the local situatedness of technology use stands in tension with broad concerns for access, efficiency, and scalability in education development initiatives (Lim, Tinio, Smith, & Bhowmik, 2018). To address the ambitious goals of SDG4 globally, solutions that give more and better access to quality learning at scale are required. However, in a scoping review of digital learning initiatives in seven developing countries, Gaible, Mayanja, and Michelazzi (2018) question whether "standardised tools" are the answer, given that roll-outs of software can "lead to unexpected and unbudgeted costs" and require massive human resources investment to manage and make sense of data gathered with these tools (p. 50). In this research, I question whether there is a middle ground rooted in the complexities of local contexts and learning with technologies, while also moving more youth toward the broader goals of quality learning identified in the Incheon Declaration (UNESCO, 2016).

Part of a larger thematic analysis of forty-four digital learning reports funded by Canada's IDRC (Hagerman & Hagerman, in press) the current analysis focuses specifically on the literacies-oriented research in this broader agenda, and the ways that digital literacies have and have not been conceptualised, supported, and practiced in five different global development contexts.

2. Conceptions of Digital Literacies

Literacies are ways of making, transforming, negotiating, and communicating meaning (New London Group, 1996). Literacies are socially situated (Gee, 1992; Heath, 1983), framed by purpose (Britt, Rouet, & Durik, 2018; RAND Reading Study Group, 2002) and require the activation of diverse and multiple skills, strategies, practices, and dispositions that are also shaped by the nature of the text being read, created or shared (Cho & Afflerbach, 2017; Leu, Kinzer, Coiro, Castek, & Henry, 2013; Mills, 2015). Literacies practices, including digital literacies practices such as blogging, social media participation, or digital video production (Lankshear & Knobel, 2011) also depend on students' interests and motivations (Curwood, Magnifico, & Lammers, 2013; Guthrie et al., 1996; Moje, Overby, Tysvaer, & Morris, 2008).

Digital literacies, in particular, are situated in digital contexts—for example, the Internet—and as such, include ways of making, transforming, negotiating, and communicating meaning that are inherently multimodal (Kress, 2003; Rowsell, 2013), deictic (Leu et al., 2013), and require skills, strategies, and dispositions that both include and extend those required for reading and writing print (Coiro, 2011; Spires, Bartlett, Garry, & Quick, 2012).

Increasingly, scholars recognize digital tools and literacies as *placed* resources (Prinsloo, 2005; Rowsell, Saudelli, Scott, & Bishop, 2013) that take on and enable the creation of meaning in relation to where they are used, when they are used, how they are used, by whom and for what situated purposes (Prinsloo & Rowsell, 2012). This view of digital tools and digital literacies practices as situated or *placed* is a core theoretical assumption underpinning the current analyses. In this way, context is seen as central, and something to work with rather than to work against or control (cf. Selwyn, 2010). A "strong contextual analysis" has also been advanced as a key recommendation by the World Bank (2016) for designing use of ICTs to support learning among children living in conflict in the Middle East and North Africa (MENA) region (p. 12).

3. Digital Literacies Teaching and Learning

Much of the theory and research on digital literacies teaching in contexts of schooling has been generated by scholars trained in, living, and working in advanced global economies (e.g., Leu et al., 2013; Mills, 2015; New London Group, 1996; Rowsell et al., 2016, Spires et al., 2012). In very broad terms, this scholarship has emphasized the importance of disciplinary problem-based inquiry and digital media production in school as promising approaches for learning digital skills and for developing foundational critical and evaluative dispositions for making media with, and from, digital texts (e.g., Coiro, Castek, & Quinn, 2016; Dwyer, 2016; Miller, 2013; Spires, Kerkhoff, & Graham, 2016; Stornaiuolo & Thomas, 2018). Several studies suggest that projects driven by students' interests and experiences, that invite collaboration, and that incorporate the use of multimodal digital composition and participatory practices can enable exploration of culture and identity, support student agency development, and digital literacies learning concomitantly (e.g., Garcia, Mirra, Morrell, Martinez, & Scorza, 2015; Hughes, 2008; Kafai, Fields, & Searle, 2014; Santoy, 2013). In sum, digital literacies instructional practices defined, developed, theorized, and researched in the Global North centralize student voice, choice, and action, while also supporting development of digital skills for particular purposes that go beyond decoding and using information. Digital literacies include knowing how to create digital texts, and how to participate in digital conversations (International Literacy Association Literacy Research Panel, 2018). Digital tools are rarely the starting point for digital literacies instructional design. Rather, teachers, who are also viewed as designers, facilitators, collaborators, and supporters, integrate technologies that advance learning goals, often in collaboration with students (Bekker, Bakker, Douma, van der Poel, & Scheltenaar, 2015; Hagerman, 2017; Spires et al., 2016).

In comparison, there is little published scholarship documenting similar approaches taking root in schools located in the Global South (Byrne & Burton, 2017; Carlson & JBS International, 2013; Gaible et al., 2018). Gaible and colleagues (2018) note that small educational

technology interventions led by NGOs or private sector investors rarely include research, which limits understanding of the local conditions under which interventions may or may not be successful (p. 49). Recent surveys conducted by GlobalKidsOnline in Ghana (UNICEF Ghana, 2017) and Montenegro (Logar, Anzelm, Lazic, & Vujacic, 2016) show that children age 9–17, use the Internet to search for information, to share photos and videos, to chat online, and to play online games at home, but at school, Internet use is mostly for practicing skills or finding information. Blogging, video production, or social media participation for learning are rarely reported as school-based activities. There could be several reasons for this, including infrastructure and teacher training—issues that have been identified in reviews of what works to support student learning more broadly in contexts of development (e.g., Evans & Popova, 2016). However, given the fundamental role that digital composition, creation, and participation are understood to play in personal, social, economic, academic, and professional activities today (e.g., International Literacy Association Literacy Research Panel, 2018; Jenkins, Ito, & boyd, 2016) research on digital creation, digital participation, online inquiry, and communication in schools in the Global South is urgently needed as a point of reference to inform the design of locally grounded digital literacies teaching interventions. As governments, NGOs, and development agencies work toward universal education for all, research is needed to inform the design of effective, contextually-grounded, digital literacies learning that prepares learners for digitally-networked and knowledge-oriented futures.

4. Research Questions

Given this need, the current study asks: How do digital learning interventions funded by the IDRC between 2016–2018 advance understandings of literacies learning, and in particular the digital literacies learning and practices of children and youth in contexts of development? To address this overarching question, the study is framed by three subquestions:

a) How have literacies interventions been designed in this set of studies?
b) How, if at all, have these interventions been shown to support digital literacies practices such as participation in social networks, composing digital texts, finding information, or critically evaluating digital information?
c) What markers of quality, as defined in the Incheon Declaration, are evident in these interventions?

5. Method

This study uses methods of descriptive analysis and thematic analysis to respond to the research questions (Braun & Clark, 2006; Miles, Huberman, & Saldaña, 2014).

5.1. Sample and Inclusion Criteria

Studies included for analysis in the current research were selected from a corpus of 44 reports supported by the IDRC between 2016–2018 (Hagerman & Hagerman, in press). Studies included for the current analysis were (a) empirical in their design and included primary data collection, (b) conducted in a school or education centre, (c) included children and youth as primary participants, (d) focused on children's literacies learning with digital applications or through interactions with digital devices. The six studies retained for analysis are summarized in Table 1.

5.2. Data Analysis

Memoing framework. To answer each of the research subquestions, I read the reports of research and used a framework informed by the research questions to guide my process of information gathering and open memoing (Miles, Huberman, & Saldaña, 2014). The criteria and definitions of markers of quality, in particular, align with the Incheon Declaration (UNESCO, 2016) and its definitions of quality education. I read for the following information across the studies:

How are the interventions designed? (descriptions)

- Stated purpose of the instructional intervention?
- Literacies learning and teaching goals?
- What digital tools are used?
- What is the role of the teacher?
- Contextual challenges?

What measured impacts on literacies are reported? (summary of findings)

Markers of quality? (with definitions)

- Equitable? Do boys and girls participate and perform equally?
- Inclusive? Do all students, including those with special learning needs, participate and benefit?
- Encourage creativity? Are children making meaning through digital creation? Are they crafting or producing new things or solving novel problems in new ways?
- Content Knowledge acquisition? Does the intervention focus on learning the core knowledges, strategies, and skills of a discipline, such as how to decode strings of letters for young learners, or how to create a program using SCRATCH for older youth?
- Analytical, problem-solving skills? Does the intervention require application of disciplinary knowledge to solve meaningful problems?
- Interpersonal and social skills? Does the intervention enable learners to collaborate, share, negotiate, work toward a common goal?

Table 1. Summary of studies retained for analysis.

Authors	Country & Context	Participants	Digital Tools
Cheung and Guo (2018)	China (Hunan)	Grades 1–3 Children	*ABRACADABRA (A Balanced Approach for Reading Always Designed to Achieve the Best Results for All)* Early literacy web-based application
Koval-Saifi and Plass (2018a)	Jordan (refugee camps)	Syrian children & their parents	*Antura & the Letters* early literacy mobile app
Koval-Saifi and Plass (2018b)	Jordan (refugee camps)	Syrian children & their parents	*Feed the Monster* early literacy mobile app
Metni (2018)	Lebanon (Beirut and rural contexts)	High School Students and their Teachers	*Raspberry Pi microcomputer, Python & Scratch programming languages*, Internet, & physical materials for projects
Oakley, Pegrum, Kheang and Seng (2018)	Cambodia in Grades 1–3	Primary Students	*Aan Khmer (Read Khmer)* early literacy mobile app
So, Shin, Wong and Lee (2018)	Mongolia	Grade 6 and Grade 10 Students & their Teachers	Mobile phones, Facebook social media platform

Once these data were curated, I read across memos to identify common and divergent trends, to categorize the design structures of the interventions, to identify themes (Braun & Clarke, 2006), and judge markers of quality. Inductive thematic analysis was used to understand the types of challenges reported in these studies. To visualize and revise the challenge themes, I used a web-based tool called Mindup. For the markers of quality, I used the definitions listed above and a simple yes/no/not clear from report framework, to evaluate each study. I discussed my analyses with the co-author of a larger study (Chris Hagerman), a historian whose expertise in the fields of international relations and education in colonial contexts, surfaced a range of critical insights. He helped me to revise and strengthen the thematic analyses so that they closely aligned with our shared understandings of the data. Together we settled on categories, themes, and judgment of quality markers.

6. Results

6.1. Design of Literacies Interventions

Fixed interventions. Four studies focused on digital software applications and their impact on young children's concepts of print and emergent reading skills (Cheung & Guo, 2018; Koval-Saifi & Plass, 2018a, 2018b; Oakley et al., 2018). Although digital in delivery, these interventions did not intentionally support or develop digital literacies skills such as website navigation or information finding. I characterized these interventions as *fixed* because the applications lead children through practice activities in pre-determined sequences engineered to support the development of foundational literacies skills such as memorizing letter names and learning letter sounds. All applications include game-based elements such as levels or rewards for particular learning achievements. There is some choice within these games; however, learners can not modify the substance of their learning because it is bounded by the design constraints of the applications and the devices used for access.

Role of the teacher. All fixed interventions were designed to minimize or eliminate the need for a teacher because in these contexts, class sizes can be large (e.g., Cambodia and China), teachers may have had limited training in how to teach literacies (e.g., Cambodia and China) or there are simply no teachers available (e.g., refugee camps).

In Table 2, I summarize the literacies learning purposes of each application and the skills practiced by participants in these four studies.

Open interventions. I characterize the studies conducted by Metni (2018) in Lebanon and So et al. (2018) in Mongolia as *open interventions*.

The Coder Maker project (Metni, 2018) was designed to "improve the quality and accessibility of learning for refugees and host communities in and outside the classroom in Lebanon using digital innovations" (p. 2). The influx of Syrian youth who have experienced trauma and/or missed many years of schooling has placed enormous pressures on Lebanese schools and raised important questions about how to build cohesive school communities. According to the observations of teachers in this study, Syrian students tend to lack confidence, often demonstrate violent behaviours, and drop out of school to work (pp. 13–15). Students in the study reported feeling disconnected and unmotivated at school. This intervention builds on principles of maker-centred learning for empowerment (Agency by Design, 2018). Teachers and students learn to code using SCRATCH (scratch.mit.edu) or Python on Raspberry Pi (https://www.raspberrypi.org). Then, as integrated

Table 2. Summary of fixed design applications, their purposes and emergent literacies skills practiced.

Application	Language	Purpose	Literacies Skills Practiced
Antura & the Letters	Arabic	Build foundational literacies skills in Arabic and improve the psychosocial well being of Syrian refugee children	Letter recognition and naming Letter sounds Sound-letter matching Sight word recognition Sight word meanings
Feed the Monster	Arabic	Build foundational literacies skills in Arabic and improve the psychosocial well being of Syrian refugee children	Letter recognition and naming Letter sounds Sound-letter matching Sight word recognition Sight word meanings
ABRACADABRA	English	To help the reading literacy proficiency of children	Letter recognition Letter sound recognition Word segmenting Modelled reading to support fluency Writing event sequences Listening comprehension Reading comprehension
Aan Khmer	Khmer	Improve the reading competencies of early grade children in Khmer	Letter recognition and naming Letter sounds Sound-letter matching Sight word recognition Sight word meanings Listening/reading comprehension (mini-stories)

teams, Syrian and Lebanese students, with teacher support, collaborate to identify and solve a problem of meaning in their community. One team, for example, designed a pair of glasses with integrated sensors to help a visually impaired girl move more safely in her world.

The mobile, gamified, participatory language learning intervention developed and tested in Mongolia (So et al., 2018) aimed to "investigate how gamification and social media can be incorporated into the design of an effective mobile-assisted language learning program in Mongolian public schools, in order to promote effective contextualized learning experiences" (p. 3). Changing climate has forced significant migration from rural areas to the capital city of Ulaanbaatar in Mongolia, putting stress on public schools. Children often attend school for half days so that two shifts of students can share the same school buildings (So et al., p. 3). The mobile, hybrid nature of this learning intervention meant that students with internet at home could continue learning English after hours. At school, and for homework, students completed participatory activities for diverse purposes on Facebook including creating videos, and role-playing shopping for clothing as their teacher served as salesperson. One teacher said, "It definitely changed my teaching styles....I realized that I could use time outside of class for student learning. I think that time should be used wisely, so I am giving students some homework to do after class" (p. 25). Digital literacies were not explicitly theorized in this study but digital literacies practices such as digital video creation and social media participation were leveraged to support English language learning.

As with the fixed interventions, the open interventions were also designed in response to situated needs. In the Lebanese context, the digital tools were placed to support social cohesion and disciplinary learning in science and computer science; in Mongolia, mobile phones and Facebook were placed to make English language learning and communication accessible beyond the very short school day. Digital literacies practices such as online reading and research, writing computer programs, creating videos, and sharing posts on Facebook were part of these intervention designs, although neither study situated these practices in digital literacies theory or research.

Role of teachers. Open interventions positioned teachers as "co-designers" who supported their students in meaningful, purposeful communication and problem-solving. Unlike the fixed interventions, and more in line with current conceptions of digital literacies teaching (e.g., Coiro et al., 2016; Spires et al., 2016), open interventions positioned teachers as dynamic experts, able to shift supports in response to learners' needs, and in ways that gradually moved learners toward complex disciplinary and digital literacies practices. For example, one teacher in the Coder Maker study said:

> Here, I am a learner too and I am discovering my students and how they are thinking, how I can do

> things in a new way....It is a shift in thinking, before I needed to control and tell students what to do in the projects....I have followed their thinking progression. It has given space for conversation, for listening, for hearing for communication. There is so much more I can and will do as a teacher. (Metni, 2018, p. 21)

Contextual challenges. Across all studies, I constructed five cross-cutting themes from the contextual challenges reported. Presented in Table 3, these themes offer a more nuanced framework for understanding the situatedness of digital literacies interventions in contexts of development. As placed resources (Prinsloo, 2005) digital tools and interventions designed for these complex realities may offer more promising pathways to learning.

Design Summary. Although fixed and open interventions were all designed to address complex constellations of local challenges in contexts of development, they were built for learners of different ages and developmental stages, and on different assumptions about technologies, teachers, and methods of supporting literacies learning. In fixed interventions, technologies were used

Table 3. Thematic analysis of contextual challenges.

Theme	Subthemes
Infrastructure	Internet Infrastructure • Unreliable electricity (Koval-Saifi & Plass, 2018a, 2018b) • No internet; spotty wifi (all six studies) • No wifi or mobile device at home for students (So et al., 2018) • Server failure (Cheung & Guo, 2018) Human Infrastructure • Someone needs to charge tablets (Oakley et al., 2018) • No safe place to keep tablets in schools. Teachers take them home and/or devise creative ways of distributing tablets so they are not all stored together (Oakley et al, 2018) Physical Infrastructure • Remedial education centres in refugee settlements sometimes used for other purposes, therefore reducing access to the apps (Koval-Saifi & Plass, 2018a, 2018b)
Time Constraints	Related to School Schedules • Need more time to build projects (Metni, 2018) • Only four hours/day at school (So et al., 2018) • Conflicts between planned workshops and school schedules (Metni, 2018) • Very short break times for peer tutoring (Oakley et al., 2018) Related to Use of Application • Less time spent learning with app than recommended (Cheung & Guo, 2018; Koval-Saifi & Plass, 2018a, 2018b; Oakley et al., 2018)
Teachers	Teacher Knowledges • Teachers need training in phonics and application use (Cheung & Guo, 2018) • Lack of technical knowledge in the school among teachers and support staff (Oakley et al., 2018) • Teacher perceptions of struggling readers as "lacking in focus" may interfere with app use for students who need the practice most (Oakley et al., 2018) Teacher Investment • Teacher facilitation required to keep language learning and online participation going on Facebook (So et al., 2018) • Coder-Maker required a great deal of time and teacher buy-in (Metni, 2018). • Additional burden to use Aan Khmer without additional compensation (Oakley et al., 2018)
Contexts in crisis	War and Trauma • Itinerant nature of life in refugee camps impacted access to the apps (Koval-Saifi & Plass, 2018a, 2018b) • "The crisis itself is putting major demands on school administrators" (Metni, 2018) Climate change • Extreme climate and economic crisis means that people in rural areas are abandoning nomadic lifestyle and moving to the city (So et al., 2018)
Systems and cultures of schooling	• Bureaucracy of permissions, scheduling, payment and reimbursement in schools (Metni, 2018) • Schools ban mobile phones (So et al., 2018) • "The majority of teachers in my school are old. While I want to bring new ideas to teaching, I often feel constrained due to the hierarchical system in my school." (So et al., 2018)

to replace or minimize the role of teachers. Digital applications were used for independent practice of discrete emergent literacies skills, but not emergent digital literacies skills. In open interventions, designed for middle-school and high-school students, teachers were empowered to design active, collaborative learning that leveraged the affordances of particular tools for particular learning purposes. Although the Incheon Declaration (UNESCO, 2016) identifies ICT literacies as fundamental for participation in knowledge-based economies, and participants in all studies used digital tools to learn disciplinary content, none of these IDRC-funded designs included conceptualizations of digital literacies learning as central research concerns.

6.2. How, If All, Have These Interventions Supported Digital Literacies Learning?

Fixed interventions. All studies of fixed interventions measured literacies outcomes with standardized early reading measures. Three of the studies (Koval-Saifi & Plass 2018a, 2018b; Oakley et al., 2018) used pre-post designs with the Early Grade Reading Assessment (RTI International, 2015), a test developed specifically for use in contexts of development. One study (Cheung & Guo, 2018) compared treatment and control participants' performance on the Group Reading Assessment and Diagnostic Evaluation (GRADE; Pearson Education, 2014) and on the Dynamic Indicators of Basic Early Literacy Skills (DIBELS; University of Oregon Centre on Teaching and Learning, 2018).

These tests measure performance on indicators understood to predict reading comprehension, such as letter naming, familiar word recognition, non-word reading (decoding), and sound-letter matching; none of them measure foundational digital literacies, or make reference to the ways that the foundational literacies skills developed with these tools might correlate with foundational digital literacies skills, such as web navigation, information search, and sharing. Given research that has shown offline reading comprehension ability predicts online reading comprehension ability (Coiro, 2011) emergent literacies skills learned via digital applications may also support emergent digital literacies skills, but this cannot be known from these studies.

That said, ABRACADABRA improved treatment participants' phonemic awareness, phonological awareness, segmenting, non-word reading, and initial sound fluency (Cheung & Guo, 2018). The composite indices on the GRADE and DIBELS tests were also statistically significantly higher for the treatment participants in this study relative to the control group. Evidence suggests that this application, more than the others, had widespread and positive effects on early literacies skills that it aimed to improve for English language learners.

The results for the other three applications were less clear. With Aan Khmer, app use was associated with gains on some predictive literacies measures for high-use participants vs. low-use participants, but a regression model showed that 34.9% of the variance in participants' reading comprehension scores was explained by eight other variables: student gender (girls did better), grade level (older children did better), parental support (more was better), ability to borrow books from the library (positive correlation), the school director's level of education (higher level was better), the presence of multi-grade classes (positive correlation), the number of tablets provided (positive correlation), and the number of peer tutors (fewer was better). This finding suggests that human and environmental factors were important determinants of reading development. Older children with access to library books and to adults who were able to create affirmative, supportive learning opportunities, did better on the literacies measures. The enabling effects of these non-app-related variables offer counterpoints to the underlying assumption that the applications alone suffice for adequate literacies learning.

For children learning Arabic with Antura and the Letters, statistically significant gains appeared at posttest on measures of non-word reading (decoding) and oral reading fluency. Similar to the findings for Aan Khmer, older children and children with some literacies knowledge at pretest showed the largest absolute gains on all measures. For Antura, boys outperformed girls on all measures. Data from the Feed the Monster study were similar. Boys generally outperformed girls on tests of letter sound knowledge and syllable reading. Yet, the rate of change for girls was higher on all tasks, suggesting that girls showed more progress in the same amount of time from their baseline levels after using this application, even though in absolute terms, they did not score as high at posttest. Older children who had some literacies knowledge before using the app performed best on comprehension measures. The application may, therefore, have been most useful as a review for children who already knew how to read.

It is important to note that the measured, positive impacts of these four applications on predictive measures does not mean that children who use these applications will become capable readers—much less digitally literate—if, for example, they lack access to rich and varied experiences with diverse printed and multimodal texts at school and at home, or if contexts limit access to rich and varied models of oral language production (Duke & Carlisle, 2011).

Open interventions. Both open intervention studies used student and teacher survey data and focus group discussions to describe the learning impacts of the intervention. The Gamified Social Media study in Mongolia (So et al., 2018) measured treatment and control group performance on tests of listening comprehension, reading comprehension, and writing skills. At posttest, reading comprehension skills had improved significantly, relative to the control group, suggesting a treatment effect for active, creative, social media participation. This was supported by student perceptions of learning gains.

One student said, "Facebook helps us to understand English topics better and to express better ideas because [Facebook] is like a continuing class" (p. 26).

In terms of the digital literacies practices reported in the Coder-Maker study, coding skills in SCRATCH and Python were not explicitly measured, although, during focus group sessions, teachers did comment on the ways students learned to integrate disciplinary and digital literacies learning. "The program...enhances all the disciplines together, it is more than just math or IT, or coding...or Rpi [Raspberry Pi] or science or language. Putting them together in Real Life this way makes it all stronger" (Metni, 2018, p. 16). Another teacher said, "We gained logic, computational thinking and basic programming skills which enables us to take our learning to the next level;...we value how technology fits together in our subjects, in math, in physics, language" (Metni, 2018, pp. 16–17). Teachers also judged students' digital learning projects on criteria such as quality of code, use of information, integration of information, collaboration, sharing knowledge, communication, and quality of the digital creation. Teachers judged the work on these criteria to be good or excellent in most cases (p. 43).

In the Social Media study, the strongest evidence for improved digital literacies practices came from students' reports of their activities. One student said, "I liked making videos with friends. It was difficult but we really enjoyed it. We spend hours to make 30-second video" (p. 26). Students also reported greater confidence with social media and a preference for its multimodal affordances for literacies-learning purposes over textbooks.

Summary of reported impacts. All of the interventions seemed to support literacies learning in some way. In terms of digital literacies learning specifically, however, only open interventions included diverse digital literacies practices designed to support disciplinary science and English language learning. Despite significant contextual challenges, these interventions offer strong models for digital literacies learning that work, in part because they embrace local needs and empower local teachers and students.

6.3. Markers of Quality

In Table 4, I synthesize reported evidence related to six key markers of quality across all six studies.

In interpreting these judgments, it is important to note that all of the interventions were intended to give access to learners who might not otherwise experience digital learning opportunities. In this way, all of the interventions are meant to advance equity and inclusion. However, it is clear that when held up to defnitions of quality, as framed by SDG4, there is variability. Judgments of equity, as presented in Table 4, were based on the relative participation and performance of boys and girls. With ABRACADABRA, boys and girls participated and performed at similar levels. With Aan Khmer, boys and girls participated equally, but girls out-performed boys on literacies measures. With the Antura and Monster apps, boys generally outperformed girls, suggesting that boys may have had more hands-on time with the application, or that the designs may have aligned with boys' interests or learning processes. For Coder-Maker, boys were more likely to participate in classroom-based projects than girls (75% boys; 25% girls), perhaps reflecting teacher biases because teachers selected the participants for workshop participation. At the community-based events in this study, more than half the participants were girls, so gender equity findings here are mixed. The Mongolia study reported no clear evidence of gender-based participation and performance.

In terms of inclusion, Aan Khmer was used by some struggling readers for extra literacies practice, but for many children, the instructions were difficult to follow and the time allotted for extra practice limited (Oakley et al., 2018, p. 95). None of the other studies reported explicitly on the participation or involvement of children with particular literacies learning needs; so, although children with reading or writing differences may have been included in these studies, it is not clear whether these children benefitted. This is a significant gap in these reports of research.

Table 4. Summary of quality markers.

	Fixed Interventions				Open Interventions	
	ABRA	**Aan Khmer**	**Antura**	**Monster**	**Coder-Maker**	**Social Media**
Equitable?	✓	✗	✗	✗	✗	⊙
Inclusive?	⊙	⊙	⊙	⊙	⊙	⊙
Creativity?	✗	✗	✗	✗	✓	✓
Content Knowledge Learning?	✓	✓	✓	✓	✓	✓
Analytical & Problem-solving skills?	✗	✗	✗	✗	✓	✓
Interpersonal & Social Skills?	✗	✓	✓	✓	✓	✓
Total Markers	2	2	2	2	4	4

Note: ✓ = Yes; ✗ = No; ⊙ = Not clear from report of research.

Regarding creativity, only the open interventions met the definition of creativity and problem-solving as building new things or solving new or meaningful problems.

In terms of interpersonal and social skills, open interventions included collaborative, communicative literacies practices in their designs. Where fixed interventions surfaced interpersonal activities, they tended to evolve organically as children shared what they learned with one another. This suggests that even if an application is designed for independent use, children may prefer to interact around it because of the situated agency such interactions afford them (Prinsloo & Krause, in press). This may be a place-based design consideration important to future work on literacies learning, including digital literacies learning, in the most challenging contexts of development. In the absence of teachers, app designs that intentionally centralize peer-to-peer sharing, interaction, questioning, and collaboration may be an important middle-ground between the independently oriented fixed applications seen in this set of reports, and open applications that require investment in teachers, teacher training, wifi, and physical spaces for learning.

Taken together, all of the interventions reviewed align with some markers of quality education as defined by UNESCO (2016). Open interventions, however, offer an advantage for creativity and problem-solving.

7. Discussion

Based on these analyses, how have digital learning interventions funded by the IDRC between 2016–2018 advanced understandings of literacies learning, and in particular the digital literacies learning and practices of children and youth in contexts of development? The analysis of these six studies offer four essential insights on which to build future research.

First, this work shows that for young children, priority investment in literacies learning in contexts of development has been directed toward fixed interventions—mobile, game-based applications that minimize the need for human teachers because they are too few or entirely absent in particular contexts. Although one application, ABRACADABRA (Cheung & Gho, 2018) supported all of the emergent literacies skills it targeted for English language learners in China, the other three applications proved less effective. When effective, gains were modest and tended to show that older children (aged 7+) and children with the strongest literacies skills at pre-test benefitted most. This suggests that independent, self-contained app use, particularly in very challenging contexts of development such as refugee camps, may not be justified for younger children. Arguably, learning letter names and sounds via mobile app is better than no literacies learning of any kind, but it seems important, given the mixed effects, to question the return on investment for this approach. Would the same level of investment in local teachers offer more literacies benefits? In a rigorous review of six syntheses of educational-intervention research conducted in diverse contexts of development globally, Evans and Popova (2016) found that "pedagogical interventions that match teaching to students' learning, and individualized, repeated teacher training associated with a specific method or task are effective at improving student learning" (p. 22). Carolson and JBS International (2013) also note that in contexts of extreme crisis, "human ware" is more important than the technologies. What really matters for student learning seems to be well-trained teachers. To find an effective middle ground, the design of digital literacies interventions should begin with a thorough contextual analysis of how to place not just devices and apps in children's hands, but also teachers who can help youth make meaning from and with these tools.

Some of the learning benefits with fixed applications seemed to come from peer interactions around app use. In the Aan Khmer study (Oakely et al., 2018) nearly 35% of the variance in reading comprehension was attributable to a constellation of non-app related factors, including access to library books and adults who were able to create opportunities for learning, suggesting that mobile and web-based applications can support some young learners in some contexts, but greater gains may be expected from interventions that emphasize peer-to-peer collaboration and include more opportunities for children to interact with diverse text genres, and to create texts through play (Marsh, 2004; Wohlwend, 2009). Funders of fixed interventions should consider a more diverse constellation of supports, including human supports, that together, might better advance the emergent literacies of young children. Conceptions of literacies must include digital literacies skills and knowledges so that investments help children to use and create all of the types of texts they are likely to encounter in their lives.

This leads to a second significant insight. Although digital in modality, none of the fixed interventions considered how digital environments interact with the early literacies skills of focus, or how these applications might be (re)designed to support early digital literacies learning in contexts of development. This is a significant limitation and deserves research attention, particularly if development agencies continue to invest in digital applications. As Leu et al. (2013) note, printed-literacies learning and digital-literacies learning are not isomorphic processes. Given the ways that digital media, tools, and networks shape literacies activities at school, at work, and in personal lives, digital literacies learning must become a priority focus for quality educational interventions globally if SDG4 is to be realized by 2030 (ILA Literacy Research Panel, 2018).

Third, the open interventions reviewed in this analysis offer promising models for integrated disciplinary and digital literacies learning in contexts of development for teens. In contexts where challenges from infrastructures to human security might be viewed as insurmountable barriers, these studies show how digital literacies practices can be integrated with disciplinary learning

practices in schools. These designs emphasized (a) student agency and choice, (b) teachers and students as co-learners and collaborators, and (c) disciplinary learning through interaction and collaborative problem-solving with digital tools. In brief, these interventions seem to align with research on what works in schools in the Global North (e.g., Agency by Design, 2018; Spires et al., 2016). Although neither study measured improvement in digital literacies skills or practices quantitatively, students and teachers perceived improvements in their coding, digital video production, and social media skills, and expressed a preference for these approaches over other types of learning.

Finally, as the global development community works toward SDG4, and considers the role of ICTs for school improvement and their potential for student learning, this set of six studies shows that both fixed and open interventions can address markers of quality education as defined in the Incheon Declaration (2016). However, only open interventions created opportunities for creative production with digital tools, for the application of digital skills to solve meaningful problems, and for long-term collaborations that allowed students to construct their own meanings with and through digital tool use (Prinsloo & Krause, in press). Researchers and funding partners should consider how to mobilize systems and resources to scale open interventions, and to explore similar designs for young children, who also deserve opportunities to create, to play, to solve meaningful problems and to leverage digital tools in ways that empower them to become fully literate. Moreover, it seems that development research agencies such as the IDRC could leverage expanded conceptions of literacies to inform funding decisions, and require strong, nuanced evidence of the ways that digital literacies interventions have been designed to reflect place.

8. Limitations

Findings are limited by the small number of empirical, literacies-oriented studies included in the original corpus of IDRC-funded research. Interventions were conducted in only five different contexts of development, and may not be applicable in parts of South America or Africa, neither of which are represented in the studies reviewed. Although I invited critical feedback from knowledgeable others, I must also recognize that my own perspectives may have occluded the importance of ideas germane to this analysis.

9. Conclusion

As governments, NGOs and development agencies work toward universal education for all (UNESCO, 2016) this study offers new insights based on six empirical studies of literacies learning with digital tools funded by Canada's IDRC. Two types of literacies interventions were identified—fixed and open. For digital literacies learning, open interventions offer the clearest promise. Even in extremely challenging contexts, these studies show that when interventions are designed for local contexts with local teachers, and when students are encouraged and supported to create diverse digital artifacts, they learn digital skills, disciplinary knowledges, and build more socially cohesive communities. To provide more youth with quality literacies education, development research agencies could require expanded conceptions of literacies learning that include creation, composition, and participation, while also funding research that centralizes social interactions, teachers, and teacher training as part of any digital learning initiative.

Acknowledgments

The author would like to thank Matthew Smith, Laurent Elder, Cristóbal Cobo, Eliane Metni, Vicki Tinio, Cher Ping Lim, Philip Abrami, Laryssa Lysenko, Glenda Cox, Michelle Willmers and Marwan Tarazi for their critical commentary on the larger report from which this research article emerged. She also thanks Chris Hagerman and three anonymous reviewers whose comments supported important revision to this manuscript.

Conflict of Interests

The author declares no conflict of interest.

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